ECOLOGY

A PUBLICATION OF THE ECOLOGICAL SOCIETY OF AMERICA

VOLUME 75, 1994

Published Eight Times per Year at Tempe, Arizona

by the

ECOLOGICAL SOCIETY OF AMERICA

This paper meets the requirements of ANSI/NISO Z39.48-1992 (Permanence of Paper).

The Ecological Society of America

OFFICERS FOR 1994–1995

President:
JUDY L. MEYER, University of Georgia

Vice President:
ROBERT K. COLWELL, University of Connecticut

Secretary:
ROBERT K. PEET, University of North Carolina

Treasurer:
LOUIS F. PITELKA, Electric Power Research Institute

Business Manager:
DUNCAN T. PATTEN, Arizona State University

AIMS

THE ECOLOGICAL SOCIETY OF AMERICA was founded in 1915 for the purpose of unifying the science of ecology, stimulating research in all aspects of the discipline, encouraging communication among ecologists, and promoting the responsible application of ecological data and principles to the solution of environmental problems. Ecology is the scientific discipline that is concerned with the relationships between organisms and their past, present, and future environments. These relationships include physiological responses of individuals, structure and dynamics of populations, interactions among species, organization of biological communities, and processing of energy and matter in ecosystems.

MEMBERSHIP

Membership is open to persons who are interested in the advancement of ecology or its applications, and to those who are engaged in any aspect of the study of organisms in relation to environment.

The classes of membership and their annual dues for 1995 are:

DEVELOPED COUNTRIES

Regular member:

Income level	Dues
<$30,000	$38.00
$30–60,000	$58.00
>$60,000	$78.00

Student member: $18.00
Life member: Contact Membership and Subscriber Services (see below)
Emeritus member: Free

Subscriptions to the journals are **not** included in the dues for *Regular, Student,* and *Emeritus* members. See below for membership subscription rates. *Regular* and *Student* members who do not wish to receive the BULLETIN may subtract $5.00 from their membership dues.

DEVELOPING COUNTRIES

Special member - A (includes subscription to ECOLOGY) $35.00
Special member - B (includes subscription to ECOLOGY + ECOLOGICAL MONOGRAPHS + ECOLOGICAL APPLICATIONS) $45.00

Special members are those in developing countries. For this class of membership only, the membership dues and journal subscriptions are combined.

PUBLICATIONS

The Society publishes a bulletin and three journals. The BULLETIN OF THE ECOLOGICAL SOCIETY OF AMERICA, issued quarterly, contains announcements of meetings of the Society and related organizations, programs, awards, articles, and items of current interest to members. The journal ECOLOGY, issued eight times a year, publishes essays and articles that report and interpret the results of original scientific research in basic and applied ecology. ECOLOGICAL MONOGRAPHS is a quarterly journal for longer ecological research articles. ECOLOGICAL APPLICATIONS, published quarterly, contains ecological research and discussion papers that have specific relevance to environmental management and policy.

1995 subscriptions are available to ESA members as follows:

	Regular	Student		Regular	Student
ECOLOGY	$60.00	$45.00	ECOLOGICAL APPLICATIONS	$30.00	$25.00
ECOLOGICAL MONOGRAPHS	$20.00	$15.00	BULLETIN OF THE ECOLOGICAL SOCIETY OF AMERICA	Free to members	

Reduced subscription rates are available for *Emeritus members* (contact Membership and Subscriber Services—see below).

Application blanks for membership may be obtained from the Ecological Society of America, Membership and Subscriber Services, Arizona State University, Box 873211, Tempe, AZ 85287-3211, to which all correspondence concerning membership should be addressed. Checks accompanying membership applications should be made payable to the ECOLOGICAL SOCIETY OF AMERICA.

ECOLOGY

VOLUME 75

ISSN 0012-9658

Established 1920

EDITOR-IN-CHIEF AND MANAGING EDITOR

Lee N. Miller

Ecological Society of America
Cornell University • 328 E. State Street • Ithaca, New York 14850-4318

BOARD OF EDITORS

Carol K. Augspurger	University of Illinois
Arthur Benke	University of Alabama
Ted J. Case	University of California—San Diego
Donald L. DeAngelis	University of Tennessee
William R. DeMott	Indiana University/Purdue University at Fort Wayne
Stephen P. Ellner	North Carolina State University
James A. Estes	National Biological Survey
David R. Foster	Harvard Forest
Steven D. Gaines	University of California—Santa Barbara
Nancy B. Grimm	Arizona State University
Douglas H. Johnson	N.B.S. N. Prairie Wildlife Research Center
E. A. Johnson	University of Calgary
Steven A. Juliano	Illinois State University
William H. Karasov	University of Wisconsin
Diane L. Marshall	University of New Mexico
Frank J. Messina	Utah State University
Thomas E. Miller	Florida State University
Gary G. Mittelbach	Michigan State University
Russell K. Monson	University of Colorado—Boulder
O. J. Reichman	Kansas State University
John T. Rotenberry	University of California—Riverside
Gaius R. Shaver	Marine Biological Laboratory
David C. Smith	Williams College
William K. Smith	University of Wyoming
Kimberly A. Sullivan	Utah State University
Nickolas M. Waser	University of California—Riverside
Arthur E. Weis	University of California—Irvine
Nelson G. Hairston, Jr.	Cornell University
Leslie A. Real	Indiana University

Concepts Section Editors

Peter M. Kareiva University of Washington
Special Features Editor

Janet Lanza University of Arkansas at Little Rock
Book Review Editor

EDITORIAL PRODUCTION STAFF

David A. Gooding—Associate Editor
Dooley Kiefer—Copy Editor Elizabeth W. Lawson—Copy Editor
Sarah G. Gagnon—Technical Editor Elizabeth N. Endres—Production Editor

ECOLOGY

Published by the
ECOLOGICAL SOCIETY OF AMERICA

Lee N. Miller
Managing Editor
Ecological Society of America
Cornell University
328 E. State Street
Ithaca, NY 14850-4318
Telephone (607) 255-3221
FAX (607) 273-3294
E-mail: esa_journals@cornell.edu

Brian D. Keller
Executive Director
Ecological Society of America
2010 Massachusetts Avenue, NW
Suite 420
Washington, DC 20036
Telephone (202) 833-8773
FAX (202) 833-8775
E-mail: brian@esa.org

Membership and Subscriber Services
Ecological Society of America
Arizona State University
Box 873211
Tempe, AZ 85287-3211
Telephone (602) 965-3000
FAX (602) 965-8087
E-mail: iacnfm@asuvm.inre.asu.edu

MANUSCRIPTS

Submit manuscripts to the Managing Editor. See Table of Contents for Instructions to Authors. For information on the status of your manuscript after submission, call Jane Shaw, Office Manager, or Jane L. Bain, Publications Assistant, at (607) 255-3221. Notify the Managing Editor if your address changes while your manuscript is in review or awaiting publication.

SPECIAL FEATURES

Suggestions for Special Features should be sent to the Special Features Editor, Peter M. Kareiva, Department of Zoology NJ-15, University of Washington, Seattle, WA 98195. Telephone: (206) 543-7095.

BOOK REVIEWS

Submit books and monographs for review to the Book Review Editor, Janet Lanza, Biology Department, University of Arkansas, Little Rock, AR 72204. Anyone who wishes to review books for Ecology should send a current *curriculum vitae*, a description of competencies, and a statement of reviewing interests to the Book Review Editor.

SUBSCRIPTIONS

Ecology is available only in combination with Ecological Applications. The 1995 combined subscription price for institutions is $290.00. Add $45.00 for postage outside the United States. For issues lost in the mails, free replacements will be supplied if written notice is received by Membership and Subscriber Services within three months of the date of publication.

BACK ISSUES

Single issues: $25.00. Complete back volumes, as available: $100.00. Special rates are available to Members. All back issues are plus postage. Orders should be sent to the Executive Director.

PERMISSIONS

Requests for permission to use copyrighted material should be directed to the Permissions Editor, Ecological Society of America, 2010 Massachusetts Avenue, NW, Suite 420, Washington, DC 20036.

CORRESPONDENCE

Correspondence regarding membership or subscriptions, including payment of membership dues, new non-member and institutional subscriptions, change of address, missing issues, and discontinuances should be addressed to Membership and Subscriber Services. Remittances should be made payable to the Ecological Society of America.

ECOLOGY (ISSN 0012-9658) (CODEN: ECOLAR) is an official publication of the Ecological Society of America. It is published eight times per year in January, March, April, June, July, September, October, and December by the Ecological Society of America, Arizona State University, Box 873211, Tempe, AZ 85287-3221. The subscription rates are listed above.

Second-class postage is paid at Tempe, AZ, and additional mailing offices.

POSTMASTER: Send address changes to ECOLOGY, Ecological Society of America, Arizona State University, Box 873211, Tempe, AZ 85287-3211.

Copyright © 1994 by the Ecological Society of America

TABLE OF CONTENTS, Volume 75, 1994

NUMBER 1, JANUARY

Special Feature—Spatial Theory

KAREIVA, P. M. Space: the final frontier for ecological theory I
TILMAN, D. Competition and biodiversity in spatially structured habitats .. 2–16
HOLMES, E. E., M. A. LEWIS, J. E. BANKS, AND R. R. VEIT. Partial differential equations in ecology: spatial interactions and population dynamics 17–29
MOLOFSKY, J. Population dynamics and pattern formation in theoretical populations 30–39
GOLDWASSER, L., J. COOK, AND E. D. SILVERMAN. The effects of variability on metapopulation dynamics and rates of invasion 40–47

Articles

WARD, D., AND D. SALTZ. Foraging at different spatial scales: dorcas gazelles foraging for lilies in the Negev desert 48–58
OHSAKI, N., AND Y. SATO. Food plant choice of *Pieris* butterflies as a trade-off between parasitoid avoidance and quality of plants 59–68
DUSSOURD, D. E., AND R. F. DENNO. Host range of generalist caterpillars: trenching permits feeding on plants with secretory canals 69–78
NAEEM, S., AND B. A. HAWKINS. Minimal community structure: how parasitoids divide resources 79–85
DUDT, J. F., AND D. J. SHURE. The influence of light and nutrients on foliar phenolics and insect herbivory 86–98
KOENIG, W. D., R. L. MUMME, W. J. CARMEN, AND M. T. STANBACK. Acorn production by oaks in central coastal California: variation within and among years 99–109
BLACK, R. A., J. H. RICHARDS, AND J. H. MANWARING. Nutrient uptake from enriched soil microsites by three Great Basin perennials 110–122
ABRAMS, M. D., M. E. KUBISKE, AND S. A. MOSTOLLER. Relating wet and dry year ecophysiology to leaf structure in contrasting temperate tree species 123–133
HOLLINGER, D. Y., F. M. KELLIHER, J. N. BYERS, J. E. HUNT, T. M. MCSEVENY, AND P. L. WEIR. Carbon dioxide exchange between an undisturbed old-growth temperate forest and the atmosphere 134–150
WOOTTON, J. T. Predicting direct and indirect effects: an integrated approach using experiments and path analysis 151–165
PECKARSKY, B. L., C. A. COWAN, AND C. R. ANDERSON. Consequences and plasticity of the specialized predatory behavior of stream-dwelling stonefly larvae 166–181
SPILLER, D. A., AND T. W. SCHOENER. Effects of top and intermediate predators in a terrestrial food web 182–196
WERNER, E. E. Ontogenetic scaling of competitive relations: size-dependent effects and responses in two anuran larvae 197–213
LARSEN, K. W., AND S. BOUTIN. Movements, survival, and settlement of red squirrel (*Tamiasciurus hudsonicus*) offspring 214–223
LAMBIN, X. Natal philopatry, competition for resources, and inbreeding avoidance in Townsend's voles (*Microtus townsendii*) 224–235
LOCHMILLER, R. L., M. R. VESTEY, AND S. T. MCMURRY. Temporal variation in humoral and cell-mediated immune response in a *Sigmodon hispidus* population 236–245

Notes and Comments

SICCAMA, T. G., S. P. HAMBURG, M. A. ARTHUR, R. D. YANAI, F. H. BORMANN, AND G. E. LIKENS. Corrections to allometric equations and plant tissue chemistry for Hubbard Brook Experimental Forest 246–248

BERGELSON, J. Changes in fecundity do not predict invasiveness: a model study of transgenic plants 249–252

VALONE, T. J., J. H. BROWN, AND E. J. HESKE. Interactions between rodents and ants in the Chihuahuan Desert: an update 252–255

ALVAREZ-BUYLLA, E. R., AND M. SLATKIN. Finding confidence limits on population growth rates: three real examples revised 255–260

Reviews 261–269

Abbreviated Instructions to Authors 270

NUMBER 2, MARCH

The Robert H. MacArthur Award Lecture

MURDOCH, W. W. Population regulation in theory and practice 271–287

Articles

REEVE, J. D., J. T. CRONIN, AND D. R. STRONG. Parasitoid aggregation and the stabilization of a salt marsh host–parasitoid system 288–295

ANDOW, D. A., AND O. IMURA. Specialization of phytophagous arthropod communities on introduced plants 296–300

SPENCER, W. E., J. TEERI, AND R. G. WETZEL. Acclimation of photosynthetic phenotype to environmental heterogeneity 301–314

ARMBRUSTER, W. S., M. E. EDWARDS, AND E. M. DEBEVEC. Floral character displacement generates assemblage structure of Western Australian Triggerplants (*Stylidium*) 315–329

AIZEN, M. A., AND P. FEINSINGER. Forest fragmentation, pollination, and plant reproduction in a Chaco dry forest, Argentina 330–351

ROY, B. A. The effects of pathogen-induced pseudoflowers and buttercups on each other's insect visitation 352–358

LOWENBERG, G. J. Effects of floral herbivory on maternal reproduction in *Sanicula arctopoides* (Apiaceae) 359–369

TYRRELL, L. E., AND T. R. CROW. Structural characteristics of old-growth hemlock–hardwood forests in relation to age 370–386

MYSTER, R. W., AND S. T. PICKETT. A comparison of rate of succession over 18 yr in 10 contrasting old fields 387–392

WALKER, M. D., P. J. WEBBER, E. H. ARNOLD, AND D. EBERT-MAY. Effects of interannual climate variation on aboveground phytomass in alpine vegetation 393–408

SILVERTOWN, J., AND J. B. WILSON. Community structure in a desert perennial community 409–417

VITOUSEK, P. M., D. R. TURNER, W. J. PARTON, AND R. L. SANFORD. Litter decomposition on the Mauna Loa environmental matrix, Hawai'i: patterns, mechanisms, and models 418–429

MUELLER, L. D., AND P. T. HUYNH. Ecological determinants of stability in model populations 430–437

HESKE, E. J., J. H. BROWN, AND S. MISTRY. Long-term experimental study of a Chihuahuan Desert rodent community: 13 years of competition 438–445

MCCOY, E. D., AND H. R. MUSHINSKY. Effects of fragmentation on the richness of vertebrates in the Florida scrub habitat 446–457

FRANK, C. L. Polyunsaturate content and diet selection by ground squirrels (*Spermophilus lateralis*) 458–463

CASE, T. J., D. T. BOLGER, AND K. PETREN. Invasions and competitive displacement among house geckos in the tropical Pacific 464–477
MESSIER, F. Ungulate population models with predation: a case study with the North American moose 478–488
PÜTZ, K., AND C. A. BOST. Feeding behavior of free-ranging King Penguins (*Aptenodytes patagonicus*) 489–497
LOCKE, A., AND W. G. SPRULES. Effects of lake acidification and recovery on the stability of zooplankton food webs 498–506
HUISMAN, J., AND F. J. WEISSING. Light-limited growth and competition for light in well-mixed aquatic environments: an elementary model 507–520
HAMILTON, D. J., C. D. ANKNEY, AND R. C. BAILEY. Predation of zebra mussels by diving ducks: an exclosure study 521–531
GARVEY, J. E., R. A. STEIN, AND H. M. THOMAS. Assessing how fish predation and interspecific prey competition influence a crayfish assemblage 532–547
VALETT, H. M., S. G. FISHER, N. B. GRIMM, AND P. CAMILL. Vertical hydrologic exchange and ecological stability of a desert stream ecosystem 548–560

Notes and Comments

MCCANN, K., AND P. YODZIS. Biological conditions for chaos in a three-species food chain 561–564
SHUMWAY, S., AND M. D. BERTNESS. Patch size effects on marsh plant secondary succession mechanisms 564–568
EBERT, D. Fractional resource allocation into few eggs: *Daphnia* as an example 568–571

Reviews 572–581

NUMBER 3, APRIL

Special Feature—Conservation Theory

KAREIVA, P. M. Ecological theory and endangered species 583
SCHEMSKE, D. W., B. C. HUSBAND, M. H. RUCKELSHAUS, C. GOODWILLIE, I. PARKER, AND J. G. BISHOP. Evaluating approaches to the conservation of rare and endangered plants 584–606
MANGEL, M. S., AND C. TIER. Four facts every conservation biologist should know about persistence 607–614
DOAK, D. F., AND L. S. MILLS. A useful role for theory in conservation 615–626

Articles

JACKSON, L. L., AND C. L. DEWALD. Predicting evolutionary consequences of greater reproductive effort in *Tripsacum dactyloides*, a perennial grass ... 627–641
GREENE, D. F., AND E. A. JOHNSON. Estimating the mean annual seed production of trees 642–647
KOLB, K. J., AND S. D. DAVIS. Drought tolerance and xylem embolism in co-occurring species of coastal sage and chaparral 648–659
STOLL, P., J. WEINER, AND B. SCHMID. Growth variation in a naturally established population of *Pinus sylvestris* 660–670
CONDIT, R., S. P. HUBBELL, AND R. B. FOSTER. Density dependence in two understory tree species in a neotropical forest 671–680
CALLAWAY, R. M. Facilitative and interfering effects of *Arthrocnemum subterminale* on winter annuals 681–686
SCHWARTZ, M. W. Natural distribution and abundance of forest species and communities in northern Florida 687–705
LACA, E. A., R. A. DISTEL, T. C. GRIGGS, AND M. W. DEMMENT. Effects of canopy structure on patch depression by grazers 706–716

BENNINGTON, C. C., AND W. V. THAYNE. Use and misuse of mixed model analysis of variance in ecological studies 717–722
COLL, M., AND D. G. BOTTRELL. Effects of nonhost plants on an insect herbivore in diverse habitats 723–731
RITLAND, D. B. Variation in palatability of queen butterflies (*Danaus gilippus*) and implications regarding mimicry 732–746
HANSKI, I., M. KUUSSAARI, AND M. NIEMINEN. Metapopulation structure and migration in the butterfly *Melitaea cinxia* 747–762
BESHERS, S. N., AND J. F. TRANIELLO. The adaptiveness of worker demography in the Attine ant *Trachymyrmex septentrionalis* 763–775
SINERVO, B., AND S. C. ADOLPH. Growth plasticity and thermal opportunity in *Sceloporus* lizards 776–790
HÖRNFELDT, B. Delayed density dependence as a determinant of vole cycles 791–806
FLUECK, W. T. Effect of trace elements on population dynamics: selenium deficiency in free-ranging black-tailed deer 807–812
WIEBE, K. L., AND G. R. BORTOLOTTI. Food supply and hatching spans of birds: energy constraints or facultative manipulation? 813–823
TONN, W. M., I. J. HOLOPAINEN, AND C. A. PASZKOWSKI. Density-dependent effects and the regulation of crucian carp populations in single-species ponds 824–834
YOSHIOKA, T., E. WADA, AND H. HAYASHI. A stable isotope study on seasonal food web dynamics in a eutrophic lake 835–846

Notes and Comments

PLEASANTS, J. M. A comparison of test statistics used to detect competitive displacement in body size 847–850
FLINN, R. C., S. ARCHER, T. W. BOUTTON, AND T. HARLAN. Identification of annual rings in an arid-land woody plant, *Prosopis glandulosa* 850–853
NELSON, B. W., V. KAPOS, J. B. ADAMS, W. J. OLIVEIRA, O. P. BRAUN, AND I. L. DO AMARAL. Forest disturbance by large blowdowns in the Brazilian Amazon 853–858

Reviews 859–866

NUMBER 4, JUNE

Articles

RUSTAD, L. E. Element dynamics along a decay continuum in a red spruce ecosysten in Maine, USA 867–879
HART, S. C., G. E. NASON, D. D. MYROLD, AND D. A. PERRY. Dynamics of gross nitrogen transformations in an old-growth forest: the carbon connection 880–891
RUESS, R. W., AND S. W. SEAGLE. Landscape patterns in soil microbial processes in the Serengeti National Park, Tanzania 892–904
NAIMAN, R. J., G. PINAY, C. A. JOHNSTON, AND J. PASTOR. Beaver influences on the long-term biogeochemical characteristics of boreal forest drainage networks 905–921
BELSKY, A. J. Influences of trees on savanna productivity: tests of shade, nutrients, and tree–grass competition 922–932
CAIN, M. L. Consequences of foraging in clonal plant species 933–944
LEHTILÄ, K., J. TUOMI, AND M. SULKINOJA. Bud demography of the mountain birch *Betula pubescens* ssp. *Tortuosa* near tree line 945–955
FORTIN, M. Edge detection algorithms for two-dimensional ecological data 956–965
MORSE, S. R., AND F. A. BAZZAZ. Elevated CO_2 and temperature alter recruitment and size hierarchies in C_3 and C_4 annuals 966–975
POLLEY, H. W., H. B. JOHNSON, AND H. S. MAYEUX. Increasing CO_2: com-

parative responses of the C_4 grass *Schizachyrium* and grassland invader *Prosopis* 976–988
MURRAY, K. G., S. RUSSELL, C. M. PICONE, K. WINNETT-MURRAY, W. SHERWOOD, AND M. L. KUHLMANN. Fruit laxatives and seed passage rates in frugivores: consequences for plant reproductive success 989–994
OHNMEISS, T. E., AND I. T. BALDWIN. The allometry of nitrogen allocation to growth and an inducible defense under nitrogen-limited growth 995–1002
BALDWIN, I. T., AND T. E. OHNMEISS. Coordination of photosynthetic and alkaloidal responses to damage in uninducible and inducible *Nicotiana sylvestris* 1003–1014
FURBISH, C., AND M. ALBANO. Selective herbivory and plant community structure in a mid-Atlantic salt marsh 1015–1022
GÓMEZ, J. M., AND R. ZAMORA. Top-down effects in a tritrophic system: parasitoids enhance plant fitness 1023–1030
CUSHMAN, J. H., V. K. RASHBROOK, AND A. J. BEATTIE. Assessing benefits to both participants in a lycaenid–ant association 1031–1041
LINDSTRÖM, E. R., H. ANDRÉN, P. ANGELSTAM, G. CEDERLUND, B. HÖRNFELDT, L. JÄDERBERG, P. LEMNELL, B. MARTINSSON, K. SKÖLD, AND J. E. SWENSON. Disease reveals the predator: sarcoptic mange, red fox predation, and prey populations 1042–1049
OWEN-SMITH, N. Foraging responses of kudus to seasonal changes in food resources: elasticity in constraints 1050–1062
DAYAN, T., AND D. SIMBERLOFF. Character displacement, sexual dimorphism, and morphological variation among British and Irish mustelids 1063–1073
HERTEL, F. Diversity in body size and feeding morphology within past and present vulture assemblages 1074–1084
NEWMAN, R. A. Effects of changing density and food level on metamorphosis of a desert amphibian, *Scaphiopus couchii* 1085–1096
LINK, W. A., R. J. BARKER, J. R. SAUER, AND S. DROEGE. Within-site variability in surveys of wildlife populations 1097–1108
WILEYTO, E. P., W. J. EWENS, AND M. A. MULLEN. Markov–recapture population estimates: a tool for improving interpretation of trapping experiments 1109–1117
ABRAMS, P. A., AND J. D. ROTH. The effects of enrichment of three-species food chains with nonlinear functional responses 1118–1130
BEDNEKOFF, P. A., AND A. I. HOUSTON. Dynamic models of mass-dependent predation, risk-sensitive foraging, and premigratory fattening in birds ... 1131–1140
MAZUMDER, A. Patterns of algal biomass in dominant odd- vs. even-link lake ecosystems 1141–1149
MILINSKI, M. Long-term memory for food patches and implications for ideal free distributions in sticklebacks 1150–1156
FOX, M. G. Growth, density, and interspecific influences on pumpkinseed sunfish life histories 1157–1171
SCHUPP, P. J., AND V. J. PAUL. Calcium carbonate and secondary metabolites in tropical seaweeds: variable effects on herbivorous fishes 1172–1185

Reviews 1186–1196
Abbreviated Instructions to Authors 1197

NUMBER 5, JULY

Articles

SIH, A., AND D. E. WOOSTER. Prey behavior, prey dispersal, and predator impacts on stream prey 1199–1207
FORRESTER, G. E. Influences of predatory fish on the drift dispersal and local density of stream insects 1208–1218

BENKE, A. C., AND D. I. JACOBI. Production dynamics and resource utilization of snag-dwelling mayflies in a blackwater river 1219–1232
BERGMAN, E., AND L. A. GREENBERG. Competition between a planktivore, a benthivore, and a species with ontogenetic diet shifts 1233–1245
RAHEL, F. J., AND J. W. NUTZMAN. Foraging in a lethal environment: fish predation in hypoxic waters of a stratified lake 1246–1253
CARPENTER, S. R., K. L. COTTINGHAM, AND C. A. STOW. Fitting predator–prey models to time series with observation errors 1254–1264
LODGE, D. M., M. W. KERSHNER, J. ALOI, AND A. P. COVICH. Effects of an omnivorous crayfish (*Orconectes rusticus*) on a freshwater littoral food web 1265–1281
BENGTSSON, J. Confounding variables and independent observations in comparative analyses of food webs 1282–1288
MANGEL, M., AND F. R. ADLER. Construction of multidimensional clustered patterns 1289–1298
CASWELL, H., AND M. C. TREVISAN. Sensitivity analysis of periodic matrix models 1299–1303
DUFFY, J. E., AND M. E. HAY. Herbivore resistance to seaweed chemical defense: the roles of mobility and predation risk 1304–1319
CARR, M. H. Effects of macroalgal dynamics on recruitment of a temperate reef fish 1320–1333
SHAPIRO, D. Y., A. MARCONATO, AND T. YOSHIKAWA. Sperm economy in a coral reef fish, *Thalassoma bifasciatum* 1334–1344
LEIPS, J., AND J. TRAVIS. Metamorphic responses to changing food levels in two species of hylid frogs 1345–1356
SJÖGREN GULVE, P. Distribution and extinction patterns within a northern metapopulation of the pool frog, *Rana lessonae* 1357–1367
WERNER, E. E., AND M. A. MCPEEK. Direct and indirect effects of predators on two anuran species along an environmental gradient 1368–1382
SCOTT, D. E. The effect of larval density on adult demographic traits in *Ambystoma opacum* 1383–1396
HUGHES, J. J., D. WARD, AND M. R. PERRIN. Predation risk and competition affect habitat selection and activity of Namib Desert gerbils 1397–1405
MINCKLEY, R. L., W. T. WCISLO, D. YANEGA, AND S. L. BUCHMANN. Behavior and phenology of a specialist bee (*Dieunomia*) and sunflower (*Helianthus*) pollen availability 1406–1419
HARVEY, J. A., I. F. HARVEY, AND D. J. THOMPSON. Flexible larval growth allows use of a range of host sizes by a parasitoid wasp 1420–1428
TUOMI, J., P. NILSSON, AND M. ÅSTRÖM. Plant compensatory responses: bud dormancy as an adaptation to herbivory 1429–1436
BORCHERT, R. Soil and stem water storage determine phenology and distribution of tropical dry forest trees 1437–1449
VILLALBA, R., T. T. VEBLEN, AND J. OGDEN. Climatic influences on the growth of subalpine trees in the Colorado Front Range 1450–1462
RICHTER, D. D., D. MARKEWITZ, C. G. WELLS, H. L. ALLEN, R. APRIL, P. HEINE, AND B. URREGO. Soil chemical change during three decades in an old-field loblolly pine (*Pinus taeda* L.) ecosystem 1463–1473
CALLAWAY, R. M., E. H. DELUCIA, AND W. H. SCHLESINGER. Biomass allocation of montane and desert ponderosa pine: an analog for response to climate change 1474–1481
AERTS, R., AND H. DE CALUWE. Effects of nitrogen supply on canopy structure and leaf nitrogen distribution in *Carex* species 1482–1490
MATLACK, G. R. Plant species migration in a mixed-history forest landscape in eastern North America 1491–1502

Notes and Comments

GOLDBERG, D. E. Influence of competition at the community level: an experimental version of the null models approach 1503–1506

DEBLONDE, G., M. PENNER, AND A. ROYER. Measuring leaf area index with the LI-COR LAI-2000 in pine stands 1507–1511
ROSENBERG, D. K., C. J. ZABEL, B. R. NOON, AND E. C. MESLOW. Northern Spotted Owls: influence of prey base—a comment 1512–1515

Reviews 1516–1525
Instructions to Authors 1526

NUMBER 6, SEPTEMBER

Special Feature—Higher Order Interactions

KAREIVA, P. M. Higher order interactions as a foil to reductionist ecology 1527–1528
BILLICK, I., AND T. J. CASE. Higher order interactions in ecological communities: what are they and how can they be detected? 1529–1543
WOOTTON, J. T. Putting the pieces together: testing the independence of interactions among organisms 1544–1551
ADLER, F. R., AND W. F. MORRIS. A general test for interaction modification 1552–1559

Articles

SERA, W. E., AND M. S. GAINES. The effect of relatedness on spacing behavior and fitness of female prairie voles 1560–1566
VAN VALKENBURGH, B., AND R. K. WAYNE. Shape divergence associated with size convergence in sympatric East African jackals 1567–1581
O'DONOGHUE, M. Early survival of juvenile snowshoe hares 1582–1592
JANZEN, F. J. Vegetational cover predicts the sex ratio of hatchling turtles in natural nests 1593–1599
SECOR, S. M., AND K. A. NAGY. Bioenergetic correlates of foraging mode for the snakes *Crotalus cerastes* and *Masticophis flagellum* 1600–1614
CIMPRICH, D. A., AND T. C. GRUBB, JR. Consequences for Carolina Chickadees of foraging with Tufted Titmice in winter 1615–1625
SUHONEN, J., K. NORRDAHL, AND E. KORPIMÄKI. Avian predation risk modifies breeding bird community on a farmland area 1626–1634
BURD, M. A probabilistic analysis of pollinator behavior and seed production in *Lobelia deckenii* 1635–1646
HEARD, S. B. Pitcher-plant midges and mosquitoes: a processing chain commensalism 1647–1660
SCHIERENBECK, K. A., R. N. MACK, AND R. R. SHARITZ. Effects of herbivory on growth and biomass allocation in native and introduced species of *Lonicera* 1661–1672
BROWN, D. G. Beetle folivory increases resource availability and alters plant invasion in monocultures of goldenrod 1673–1683
ERNEST, K. A. Resistance of creosotebush to mammalian herbivory: temporal consistency and browsing-induced changes 1684–1692
BRISSON, J., AND J. F. REYNOLDS. The effect of neighbors on root distribution in a creosotebush (*Larrea tridentata*) population 1693–1702
BALDWIN, I. T., M. KARB, AND T. E. OHNMEISS. Allocation of ^{15}N from nitrate to nicotine: production and turnover of a damage-induced mobile defense 1703–1713
HAY, M. E., Q. E. KAPPEL, AND W. FENICAL. Synergisms in plant defenses against herbivores: interactions of chemistry, calcification, and plant quality 1714–1726
FACELLI, J. M. Multiple indirect effects of plant litter affect the establishment of woody seedlings in old fields 1727–1735
SPERRY, J. S., K. L. NICHOLS, J. E. SULLIVAN, AND S. E. EASTLACK. Xylem embolism in ring-porous, diffuse-porous, and coniferous trees of northern Utah and interior Alaska 1736–1752
READER, R. J., S. D. WILSON, J. W. BELCHER, I. WISHEU, P. A. KEDDY, D.

TILMAN, E. C. MORRIS, J. B. GRACE, J. B. MCGRAW, H. OLFF, R. TURKINGTON, E. KLEIN, Y. LEUNG, B. SHIPLEY, R. VAN HULST, M. E. JOHANSSON, C. NILSSON, J. GUREVITCH, K. GRIGULIS, AND B. E. BEISNER. Plant competition in relation to neighbor biomass: an intercontinental study with *Poa pratensis* 1753–1760
BUSH, M. B., AND P. A. COLINVAUX. Tropical forest disturbance: paleoecological records from Darien, Panama 1761–1768
ENGEMAN, R. M., R. T. SUGIHARA, L. F. PANK, AND W. E. DUSENBERRY. A comparison of plotless density estimators using Monte Carlo simulation 1769–1779
ANDERSON, D. R., K. P. BURNHAM, AND G. C. WHITE. AIC model selection in overdispersed capture–recapture data 1780–1793
RIBBENS, E., J. A. SILANDER, JR., AND S. W. PACALA. Seedling recruitment in forests: calibrating models to predict patterns of tree seedling dispersion 1794–1806
GESSNER, M. O., AND E. CHAUVET. Importance of stream microfungi in controlling breakdown rates of leaf litter 1807–1817
BRÖNMARK, C. Effects of tench and perch on interactions in a freshwater, benthic food chain 1818–1828

Notes and Comments

TERBORGH, J. W., AND S. J. WRIGHT. Effects of mammalian herbivores on plant recruitment in two neotropical forests 1829–1833

Ratio-dependent Predation—Some Comments on an *Ecology* Special Feature

GLEESON, S. K. Density dependence is better than ratio dependence 1834–1835
SARNELLE, O. Inferring process from pattern: trophic level abundances and imbedded interactions 1835–1841
ABRAMS, P. A. The fallacies of ratio-dependent predation 1842–1850

Reviews 1851–1860

NUMBER 7, OCTOBER

The Robert H. MacArthur Award Lecture

VITOUSEK, P. M. Beyond global warming: ecology and global change 1861–1876

Articles

HECKATHORN, S. A., AND E. H. DELUCIA. Drought-induced nitrogen retranslocation in perennial C_4 grasses of tallgrass prairie 1877–1886
MARSHALL, J. D., AND J. ZHANG. Carbon isotope discrimination and water-use efficiency in native plants of the north-central Rockies 1887–1895
DOMÍNGUEZ, C. A., AND R. DIRZO. Effects of defoliation on *Erythroxylum havanense*, a tropical proleptic species 1896–1902
MASAKI, T., Y. KOMINAMI, AND T. NAKASHIZUKA. Spatial and seasonal patterns of seed dissemination of *Cornus controversa* in a temperate forest 1903–1910
VANDER WALL, S. B. Seed fate pathways of antelope bitterbrush: dispersal by seed-caching yellow pine chipmunks 1911–1926
ORTH, R. J., M. LUCKENBACH, AND K. A. MOORE. Seed dispersal in a marine macrophyte: implications for colonization and restoration 1927–1939
DIXON, P. Testing spatial segregation using a nearest-neighbor contingency table 1940–1948
HORVITZ, C. C., AND D. W. SCHEMSKE. Effects of dispersers, gaps, and predators on dormancy and seedling emergence in a tropical herb 1949–1958
THIJS, H., J. R. SHANN, AND J. D. WEIDENHAMER. The effect of phytotoxins on competitive outcome in a model system 1959–1964

BEVER, J. D. Feedback between plants and their soil communities in an old field community 1965–1977
CARROLL, A. L., AND D. T. QUIRING. Intratree variation in foliage development influences the foraging strategy of a caterpillar 1978–1990
BECERRA, J. X. Squirt-gun defense in *Bursera* and the chrysomelid counterploy 1991–1996
BERNAYS, E. A., K. BRIGHT, N. GONZALEZ, AND J. ANGEL. Dietary mixing in a generalist herbivore: tests of two hypotheses 1997–2006
MARQUIS, R. J., AND C. J. WHELAN. Insectivorous birds increase growth of white oak through consumption of leaf-chewing insects 2007–2014
JOHNSON, C. Nutritional ecology of a mycophagous marsupial in relation to production of hypogeous fungi 2015–2021
FAGAN, W. F., AND L. E. HURD. Hatch density variation of a generalist arthropod predator: population consequences and community impact 2022–2032
MARGULES, C. R., G. MILKOVITS, AND G. SMITH. Contrasting effects of habitat fragmentation on the scorpion *Cercophonius squama* and an amphipod .. 2033–2042
SMITH, S. M. Social influences on the dynamics of a northeastern Black-capped Chickadee population 2043–2051
NICHOLS, J. D., J. E. HINES, K. H. POLLOCK, R. L. HINZ, AND W. A. LINK. Estimating breeding proportions and testing hypotheses about costs of reproduction with capture–recapture data 2052–2065
SCHRAG, S. J., G. T. NDIFON, AND A. F. READ. Temperature-determined outcrossing ability in wild populations of a simultaneous hermaphrodite snail 2066–2077
MCINTOSH, A. R., AND C. R. TOWNSEND. Interpopulation variation in mayfly antipredator tactics: differential effects of contrasting predatory fish 2078–2090
CREED, R. P., JR. Direct and indirect effects of crayfish grazing in a stream community 2091–2103
WELLBORN, G. A. Size-biased predation and prey life histories: a comparative study of freshwater amphipod populations 2104–2117
HILL, A. M., AND D. M. LODGE. Diel changes in resource demand: competition and predation in species replacement among crayfishes 2118–2126
COTTINGHAM, K. L., AND S. R. CARPENTER. Predictive indices of ecosystem resilience in models of north temperate lakes 2127–2138

Notes and Comments

SOLOW, A. R. On the Bayesian estimation of the number of species in a community 2139–2142

Reviews 2143–2150

NUMBER 8, DECEMBER

Articles

YUND, P. O., AND M. A. MCCARTNEY. Male reproductive success in sessile invertebrates: competition for fertilizations 2151–2167
MALLIN, M. A., AND H. W. PAERL. Planktonic trophic transfer in an estuary: seasonal, diel, and community structure effects 2168–2184
MORGAN, S. G., AND J. H. CHRISTY. Plasticity, constraint, and optimality in reproductive timing 2185–2203
TANNER, J. E., T. P. HUGHES, AND J. H. CONNELL. Species coexistence, keystone species, and succession: a sensitivity analysis 2204–2219
KENNEDY, M., C. R. SHAVE, H. G. SPENCER, AND R. D. GRAY. Quantifying the effect of predation risk on foraging bullies: no need to assume an IFD 2220–2226
GUTIERREZ, A. P., N. J. MILLS, S. SCHREIBER, AND C. ELLIS. A physiologically based tritrophic perspective on bottom-up–top-down regulation of populations 2227–2242

BRETT, M. T., K. WIACKOWSKI, F. S. LUBNOW, A. MUELLER-SOLGER, J. J. ELSER, AND C. R. GOLDMAN. Species-dependent effects of zooplankton on planktonic ecosystem processes in Castle Lake, California 2243–2254
LOOSE, C. J., AND P. DAWIDOWICZ. Trade-offs in diel vertical migration by zooplankton: the costs of predator avoidance 2255–2263
GOATER, C. P. Growth and survival of postmetamorphic toads: interactions among larval history, density, and parasitism 2264–2274
LAFFERTY, K. D., D. T. SAMMOND, AND A. M. KURIS. Analysis of larval trematode communities 2275–2285
BROWN, J. S., B. P. KOTLER, AND W. A. MITCHELL. Foraging theory, patch use, and the structure of a Negev Desert granivore community 2286–2300
HANKS, L. M., AND R. F. DENNO. Local adaptation in the armored scale insect *Pseudaulacaspis pentagona* (Homoptera: Diaspididae) 2301–2310
BERENBAUM, M. R., AND A. R. ZANGERL. Costs of inducible defense: protein limitation, growth, and detoxification in parsnip webworms 2311–2317
SIPE, T. W., AND F. A. BAZZAZ. Gap partitioning among maples (*Acer*) in central New England: shoot architecture and photosynthesis 2318–2332
ZAK, D. R., D. TILMAN, R. R. PARMENTER, C. W. RICE, F. M. FISHER, J. VOSE, D. MILCHUNAS, AND C. W. MARTIN. Plant production and soil microorganisms in late-successional ecosystems: a continental-scale study 2333–2347
SCHEU, S., AND D. PARKINSON. Effects of invasion of an aspen forest (Canada) by *Dendrobaena octaedra* (Lumbricidae) on plant growth 2348–2361
AERTS, R., AND H. DE CALUWE. Nitrogen use efficiency of *Carex* species in relation to nitrogen supply 2362–2372
KIELLAND, K. Amino acid absorption by arctic plants: implications for plant nutrition and nitrogen cycling 2373–2383
KOHORN, L. U. Shoot morphology and reproduction in jojoba: advantages of sexual dimorphism 2384–2394
MONTALVO, A. M. Inbreeding depression and maternal effects in *Aquilegia caerulea*, a partially selfing plant 2395–2409
VAN GROENENDAEL, J., H. DE KROON, S. KALISZ, AND S. TULJAPURKAR. Loop analysis: evaluating life history pathways in population projection matrices 2410–2415
BERTNESS, M. D., AND S. M. YEH. Cooperative and competitive interactions in the recruitment of marsh elders 2416–2429
SILVERTOWN, J., M. E. DODD, K. MCCONWAY, J. POTTS, AND M. CRAWLEY. Rainfall, biomass variation, and community composition in the Park Grass Experiment 2430–2437
MALCOLM, J. R. Edge effects in central Amazonian forest fragments 2438–2445
LI, H., AND J. F. REYNOLDS. A simulation experiment to quantify spatial heterogeneity in categorical maps 2446–2455

Notes and Comments

LINK, W. A., AND K. U. KARANTH. Correcting for overdispersion in tests of prey selectivity 2456–2459
NAY, S. M., K. G. MATTSON, AND B. T. BORMANN. Biases of chamber methods for measuring soil CO_2 efflux demonstrated with a laboratory apparatus 2460–2463

Reviews 2464–2472
Ad Hoc Editors of Manuscripts 2473
Reviewers of Manuscripts 2473–2481
Index for Volume 75
Author Index 2482–2484
Key Word Index 2485–2495
Book Review Index 2496–2500

THIS PERIODICAL MAY BE COPYRIGHTED, IN
WHICH CASE THE CONTENTS REMAIN THE PROPERTY
OF THE COPYRIGHT OWNER. THE MICROFORM
EDITION IS REPRODUCED BY AGREEMENT WITH
THE PUBLISHER. DUPLICATION OR RESALE WITHOUT
PERMISSION IS PROHIBITED.

UNIVERSITY MICROFILMS INTERNATIONAL,
ANN ARBOR, MICHIGAN